SIS GLOBAL FORUM 2019

Managing Wells with Flow Assurance in the Karachaganak Field for Sustainable Production using OLGA

Monaco

18 September 2019

Karachaganak

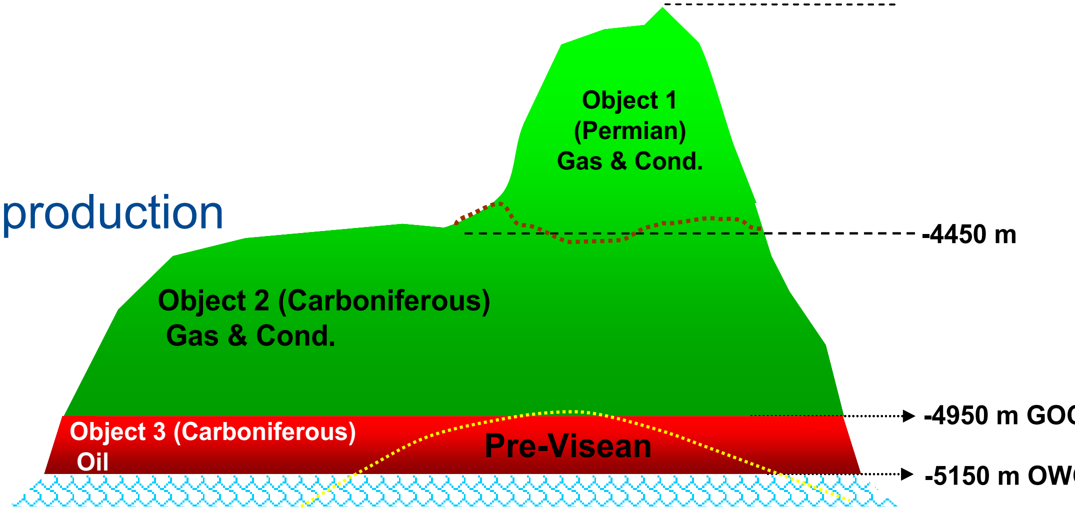
Agenda

- Introduction
- Objectives
- OLGA results
- Conclusion and recommendation

INTRODUCTION

- One of the world's largest oil & gas condensate fields;
- Discovered in 1979;
- Gross reserves – over 2.4 billion barrels of condensate and 16 tcf of gas;
- Operated by Karachaganak Petroleum Operating B.V.:
  - Shell / Eni (29.25% each)
  - Chevron (18%)
  - Lukoil (13.5%)
  - KMG (10%)

- Current production focus on liquids production (Object 3)



- Karachaganak is complex field
  - Geology
  - Heterogeneous of formation
  - Variation of fluid properties with depth

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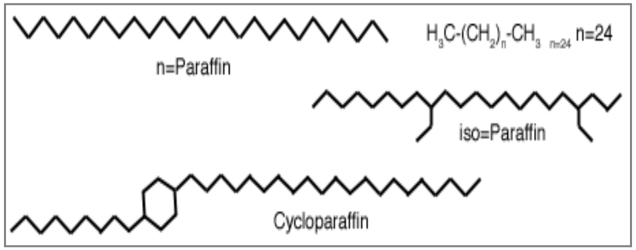
OBJECTIVES

- The primary objective is to present the application of transient multiphase flow simulator as an aid to predicting production system performance with solids deposition in tubing and flowline in the Karachaganak field

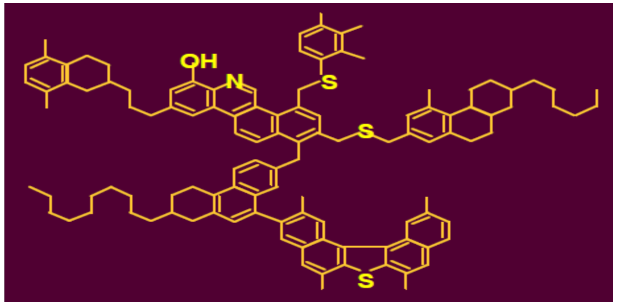
- The secondary objective is to able to provide solutions using modelling to prevent production losses

Wax, Asphaltenes and Hydrates

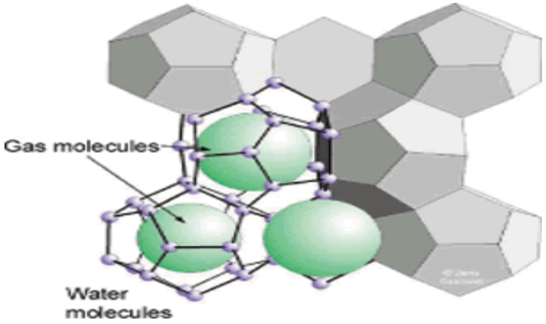
- **Wax –** mainly consists of heavy high molecular weight normal paraffins, varying amounts of cycloparaffins, isoparaffins



- **Asphaltenes –** are complex heavy hydrocarbon molecules defined to be soluble in benzene and insoluble in low molecular weight n-alkanes



- **Gas Hydrate –** are complex molecular structure is a mixture of water and gas molecules forming under certain temperature and pressure conditions.



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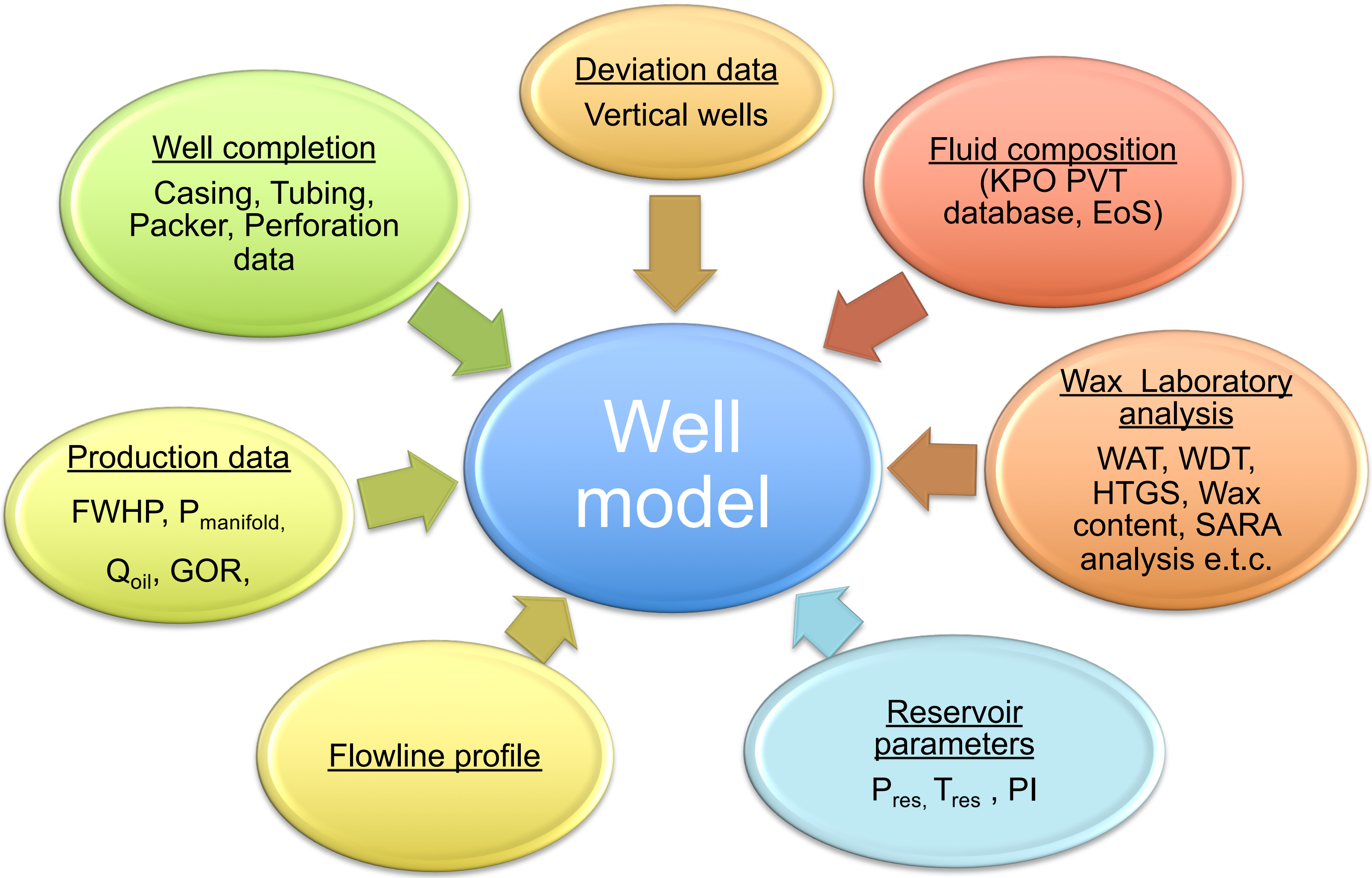
INPUT DATA



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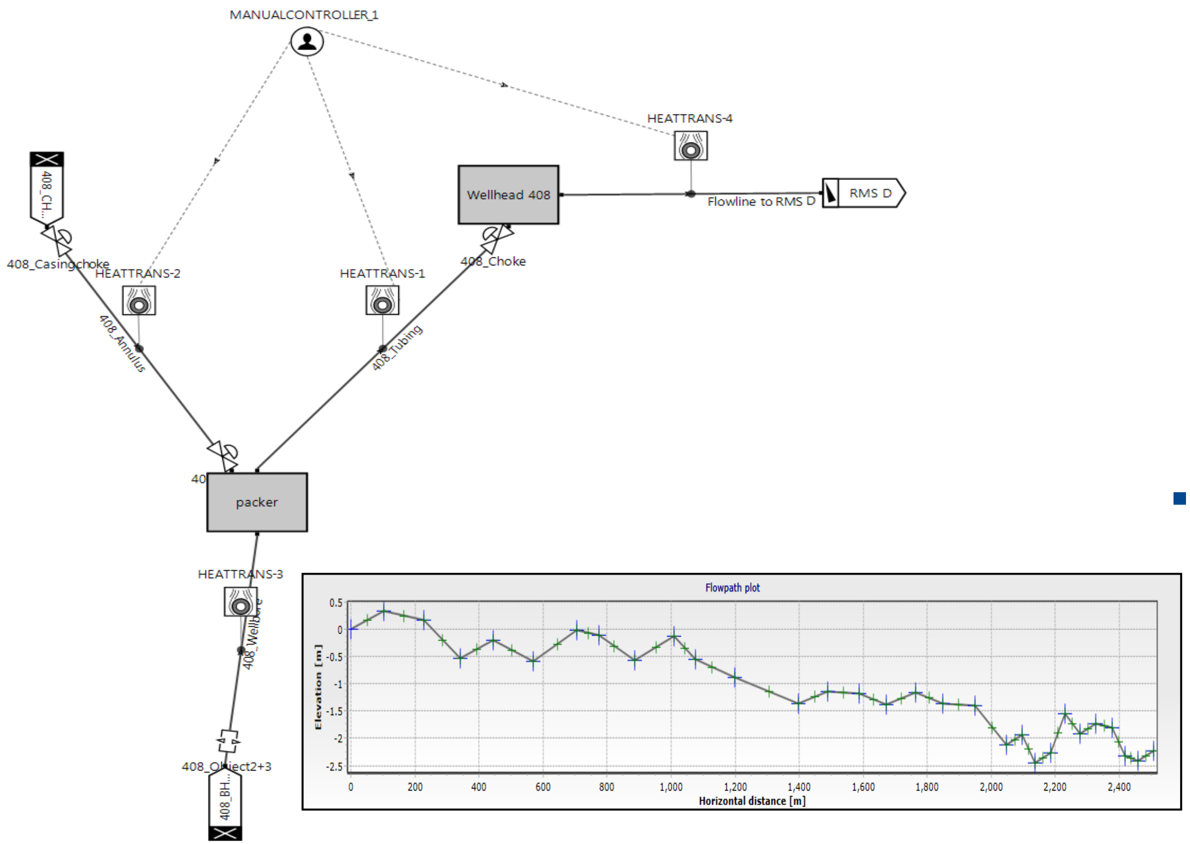
Well D08 - Wax deposition

- Well background
- Model setup
- Well performance matching
- Wax deposition assessment
- Conclusion

Well D08 - Wax deposition

Model setup

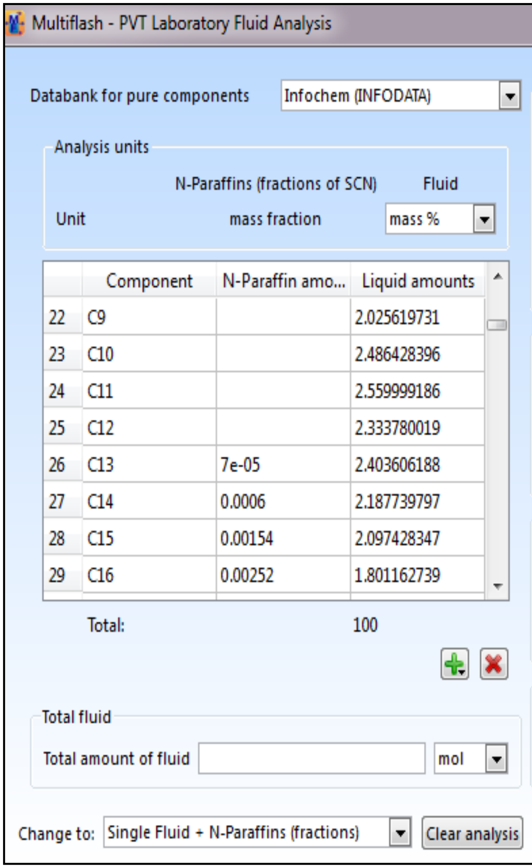


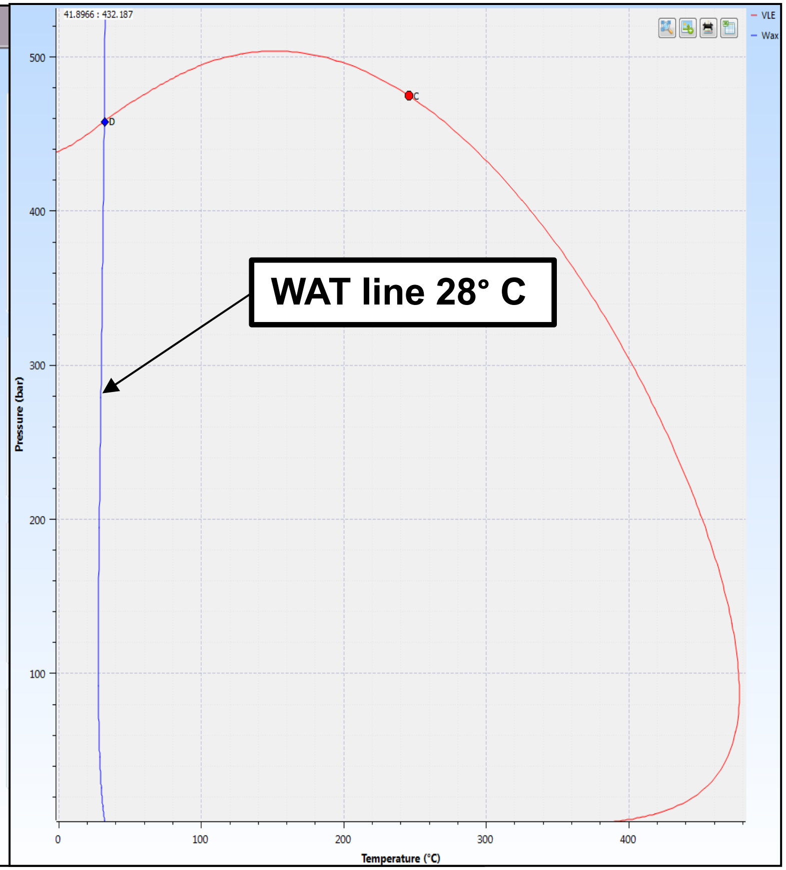
- Input data:
  - Pres=390 bar
  - Pslot=73 bar
  - PI=1 sm3/d/bar
  - GOR ~ 660 sm3/sm3
  - PI and GOR were selected to match Average Oil Rate: 180 sm3/d

- Uncertainties:
  - PVT
  - Where and when Deposition occurs ?

Well D08 - Wax deposition

Model setup





- Fluid model was created and calibrated based with Laboratory data - WAT, WDT, rheology and wax content in Multiflash
- Blue line shows the wax appearance temperature (WAT) calculated by Wilson model within Multiflash
- To the right of the WAT curve no wax formation is expected

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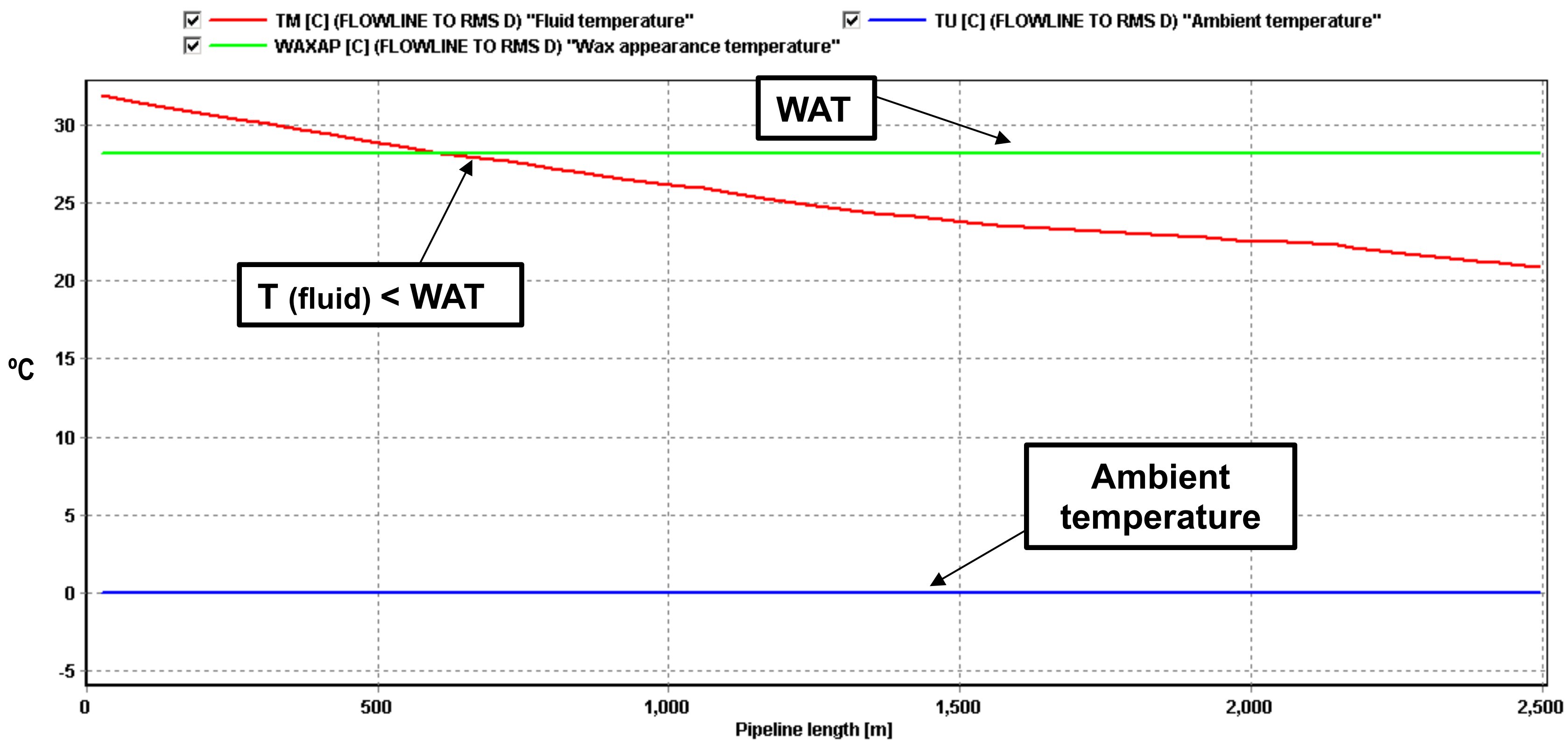
Well D08 - Wax deposition

Well performance matching – Fluid temperature in flowline



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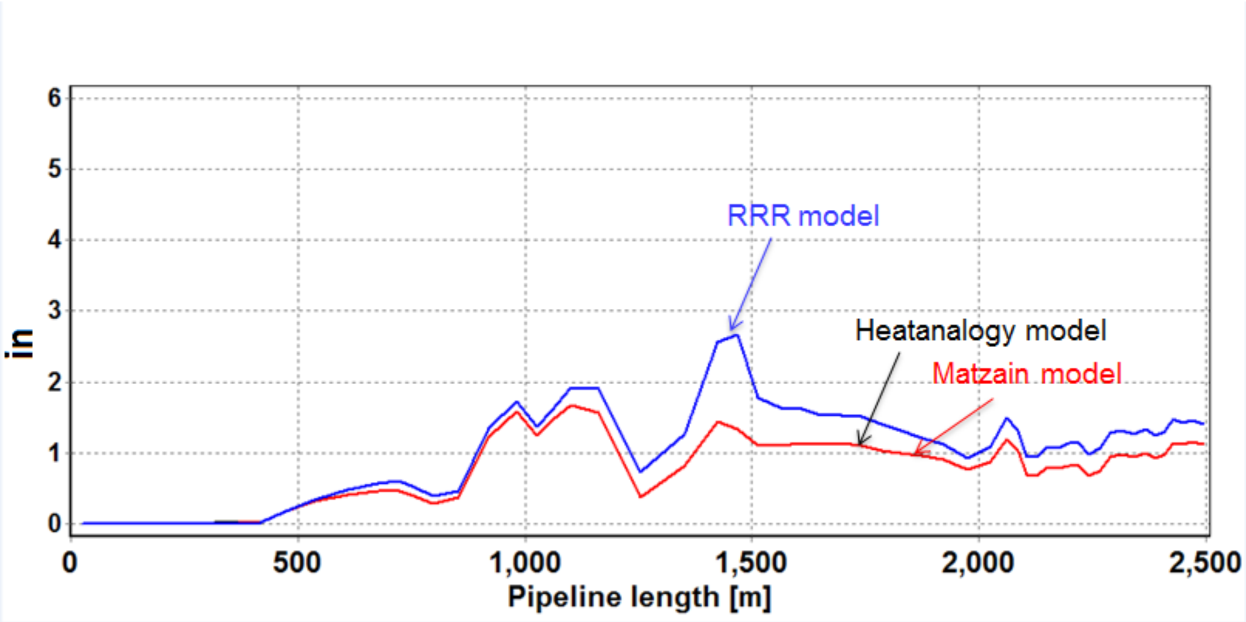
Well D08 - Wax deposition

Well performance matching – Flowline plug

- Prediction of wax deposition in flowline, requires selecting a period of a plug formation for matching
- Matzain, RRR, Heatanalogy models at different diffusion and shear coefficients built
- RRR model gave the highest wax deposition



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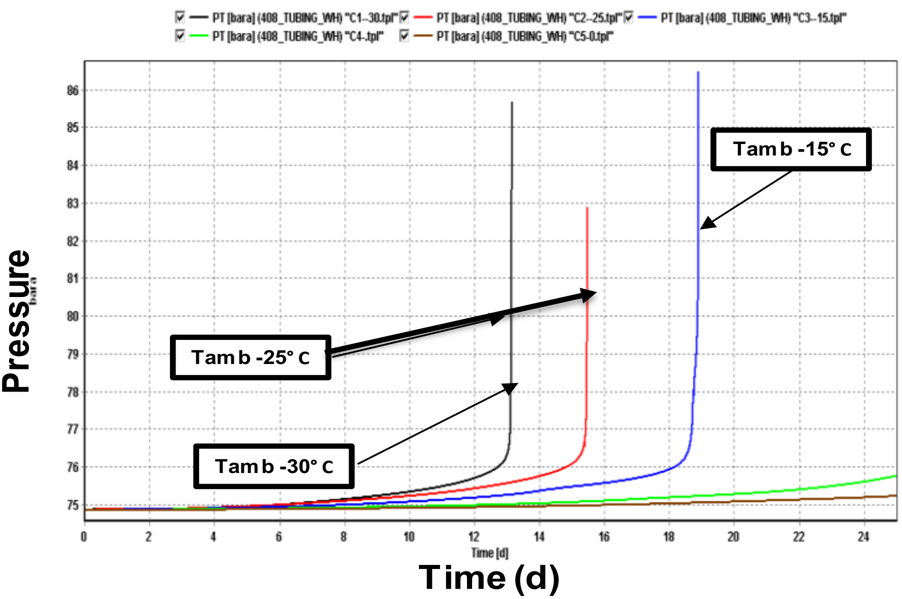
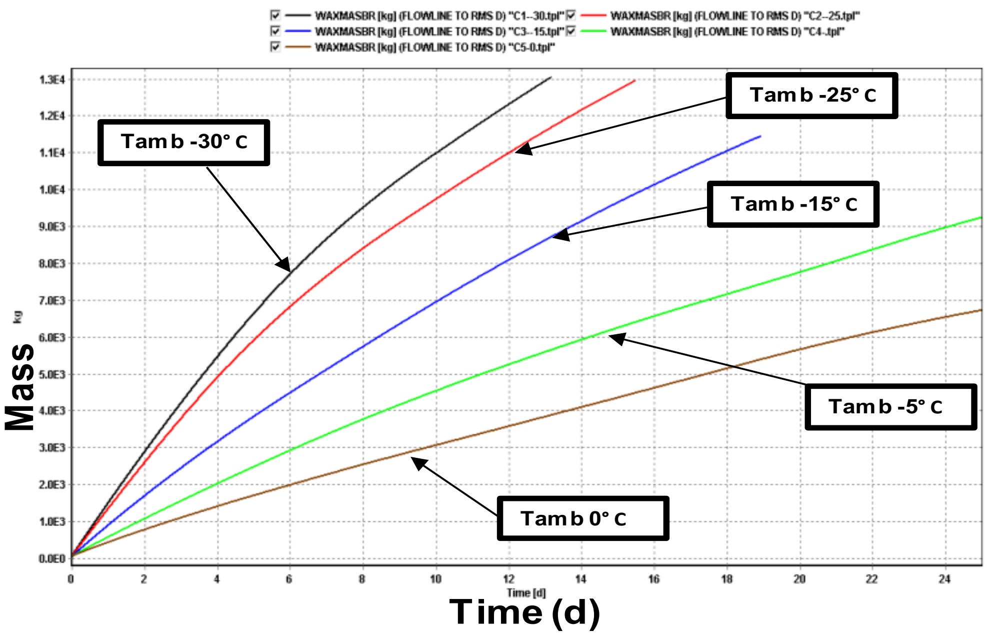
Well D08 - Wax deposition

Wax deposition assessment in flowline



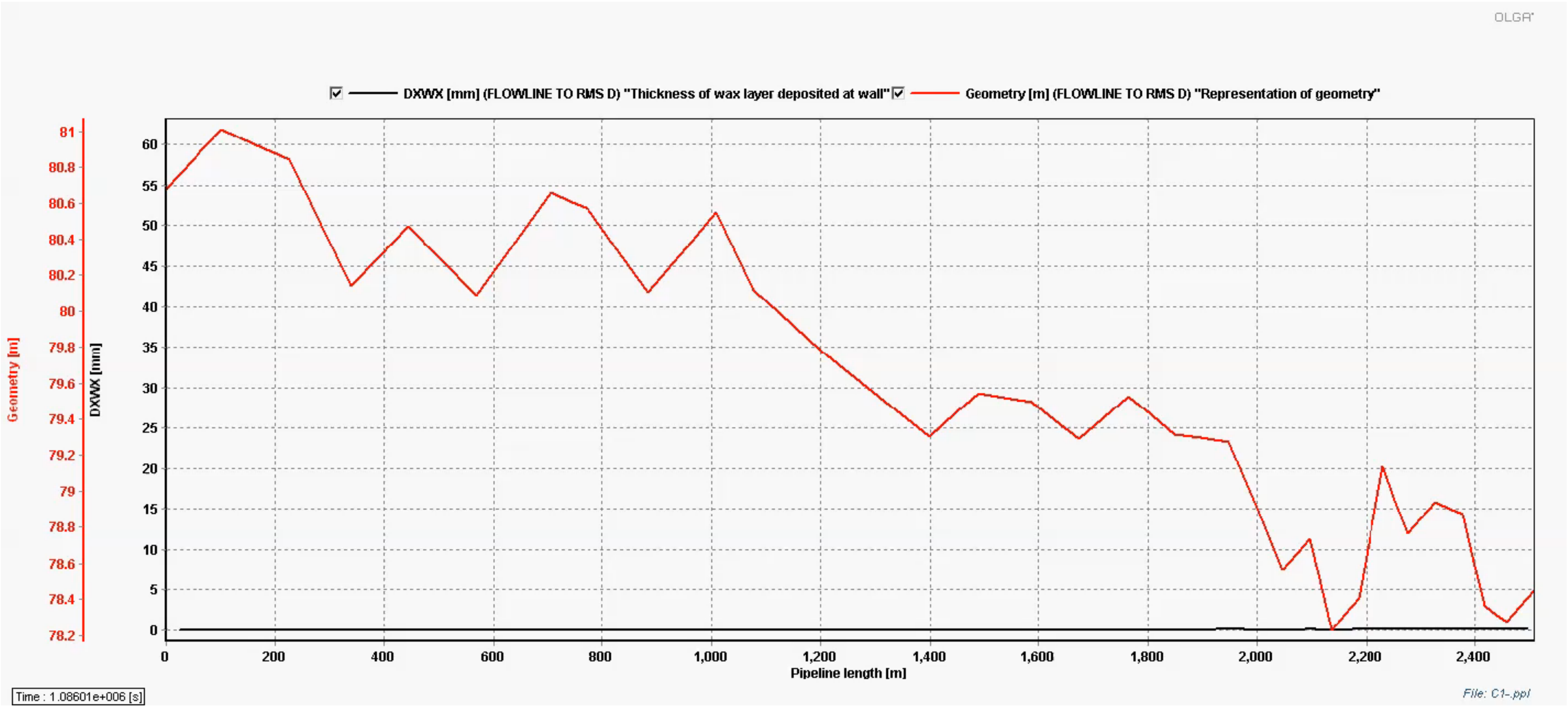


- OLGA predicts plugging of flowline at different ambient temperatures

- Mass of wax deposit at different temperatures
- For a given wax mass threshold at which plugging can be avoided, chemical injection frequency can be set up

Well D08 - Wax deposition

Wax deposition assessment in flowline



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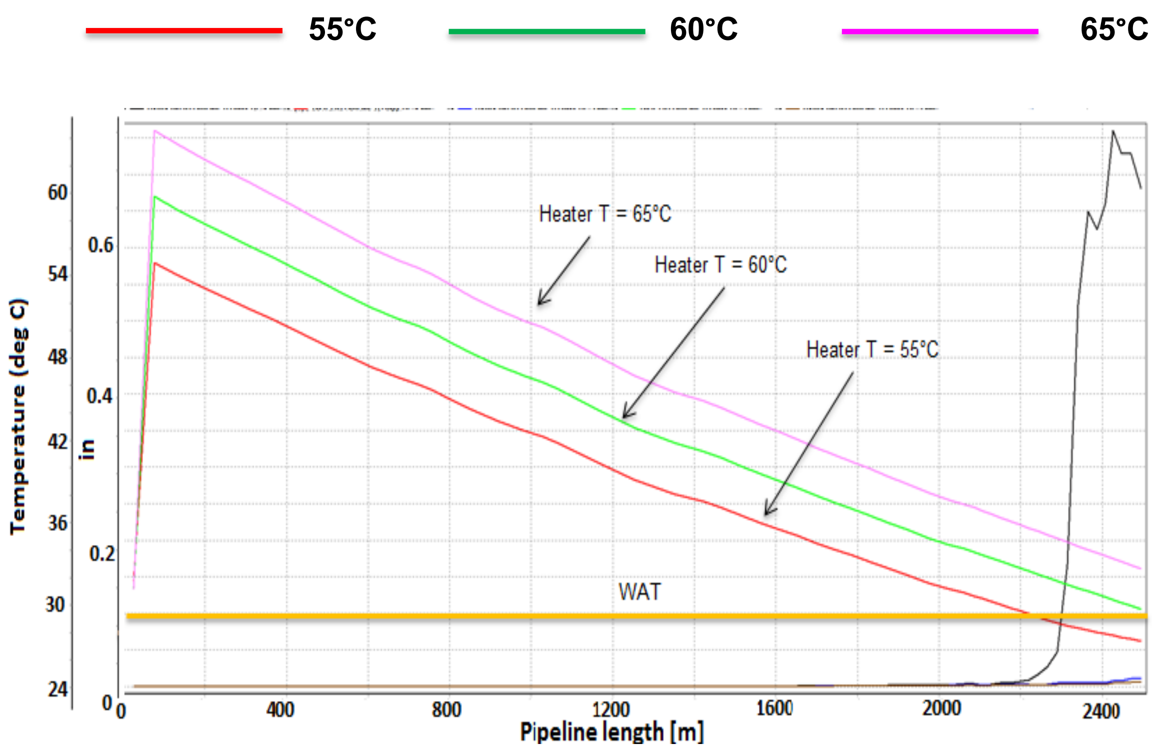
Well D08 - Wax deposition

Wax deposition assessment with heater

- Placing heater (Tout=65ºC) near wellhead has a significant impact on a temperature profile
- Heating doesn't eliminate wax deposition completely
- However, reduces the amount of wax deposition in flowline
- Eliminates plug formation (simulation until 25 days)
- Chemical injection in both well and flowline is required, however with a reduced frequency



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Well D08 - Wax deposition

Well D08 Production with Reactive vs. Proactive Intervention Strategy

	Reactive Intevention Strategy					Proactive Intevention Strategy and Transient Simulation Model Benefits				
Date	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Cummulative production forecast (bbls)	30444.7	23916.75	22400.95	23387.65	26047.45	29279.25	25117.95	26319.15	26862.55	25661.35
Actual Production cumumlative volume (bbls)	16683	27776	10527	34023	3927	35543	28524	37725	33421	35944
Cummulative Production losses (bbls)	13761	0	11874	0	22120	0	0	0	0	0
Cumulative Production Gains (bbls)	0	3859	0	10635	0	6264	3406	11406	6558	10283
Gains in %		16%		45%		21%	14%	43%	24%	40%
Total cost of Intervention, $	0	642	9,437	14,069	10,227	321	7,950	1,285	6,327	11,528

- **Reactive**
  - **Downtime – 50%**
  - **Loss = 22 000 bbl = -1.3 M USD**
  - **Intervention cost – 10K USD**
- **Proactive**
  - **Intervention cost – 10K USD**
  - **Meet production target**
  - **90% uptime**

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Well D08 - Wax deposition

Conclusion

- Well flowing condition of the model matched to available measured data
- Wax deposition in the flow line occurs from -25°C to 0°C
- OLGA reproduces flowline plugging behavior
- RRR model predicted the highest wax deposit matching plugging behavior of D08
- Heating the wellhead reduces wax deposition but doesn't eliminate it completely
- Proactive dosage with solvent keep the well on sustainable flow (uptime 90%) throughout the year
  - Monitoring flow line pressure increase
  - Previously well was a seasonal well – no flow in winter months

D20 - HYDRATE

- Well background
- Model setup
- Hydrate formation assessment
- Hydrate mitigation
- Conclusion

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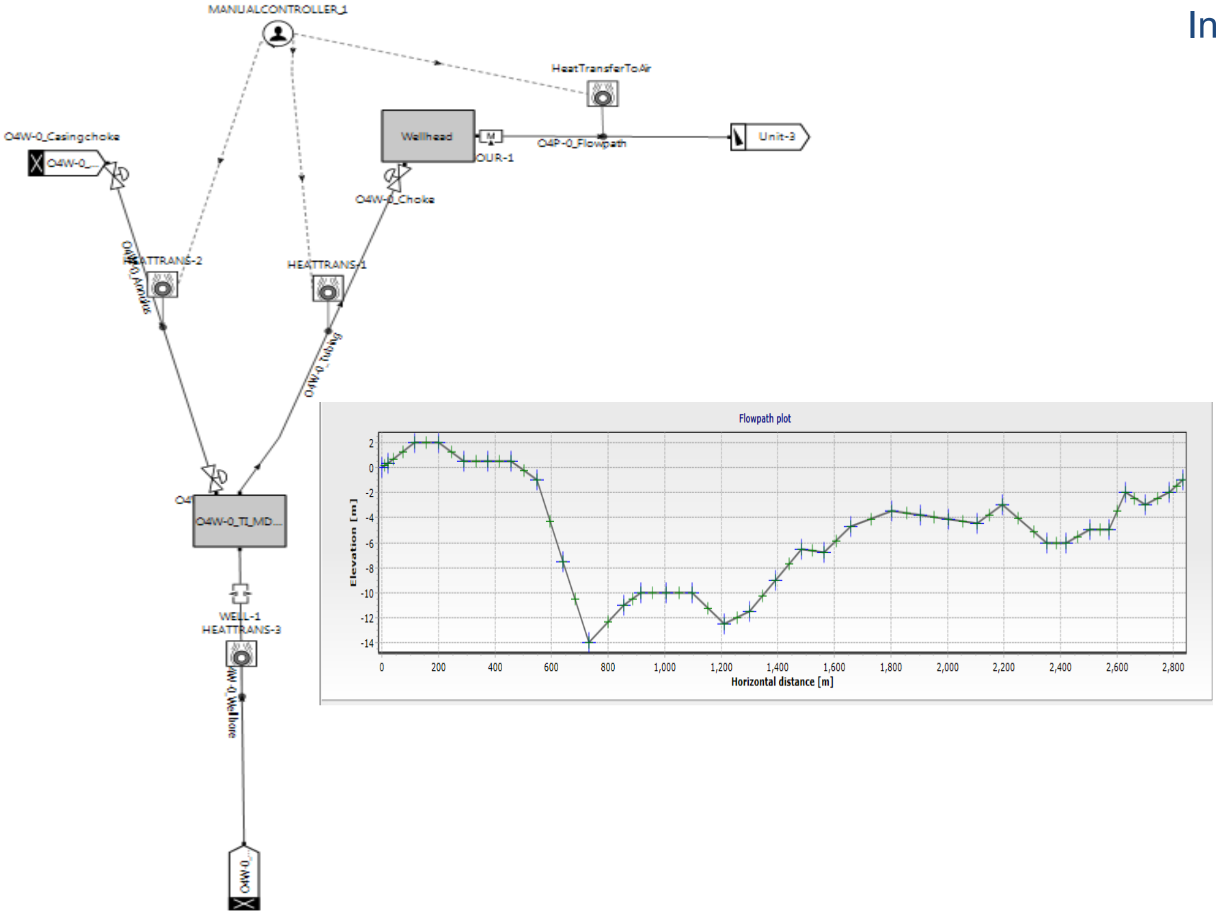
D20 - HYDRATE

Model setup



Input data:

- Pres=343 bar
- Pslot=100 bar
- PI=4.4 sm3/d/bar
- GOR ~ 1300 sm3/sm3

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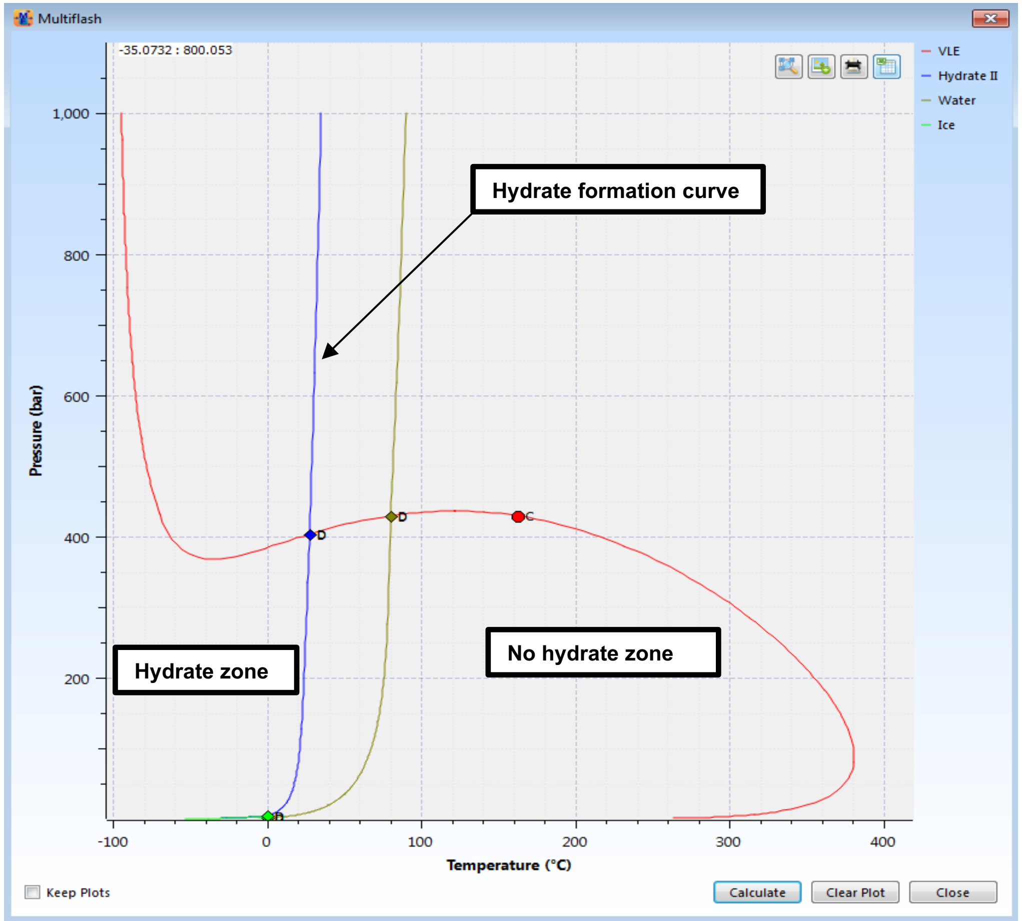
D20 - HYDRATE

Model setup

	Fluid composition	
	Component	Amount (mol)
1	H2S	4.079
2	CO2	5.433
3	METHANE	66.833
4	ETHANE	6.064
5	PROPANE	3.262
6	N-BUTANE	1.984
7	C6	2.539
8	C7-9	3.646
9	C10-14	3.053
10	C15-17	0.911
11	C18-25	1.2
12	C26+	0.995
13	WATER	0.3606542838



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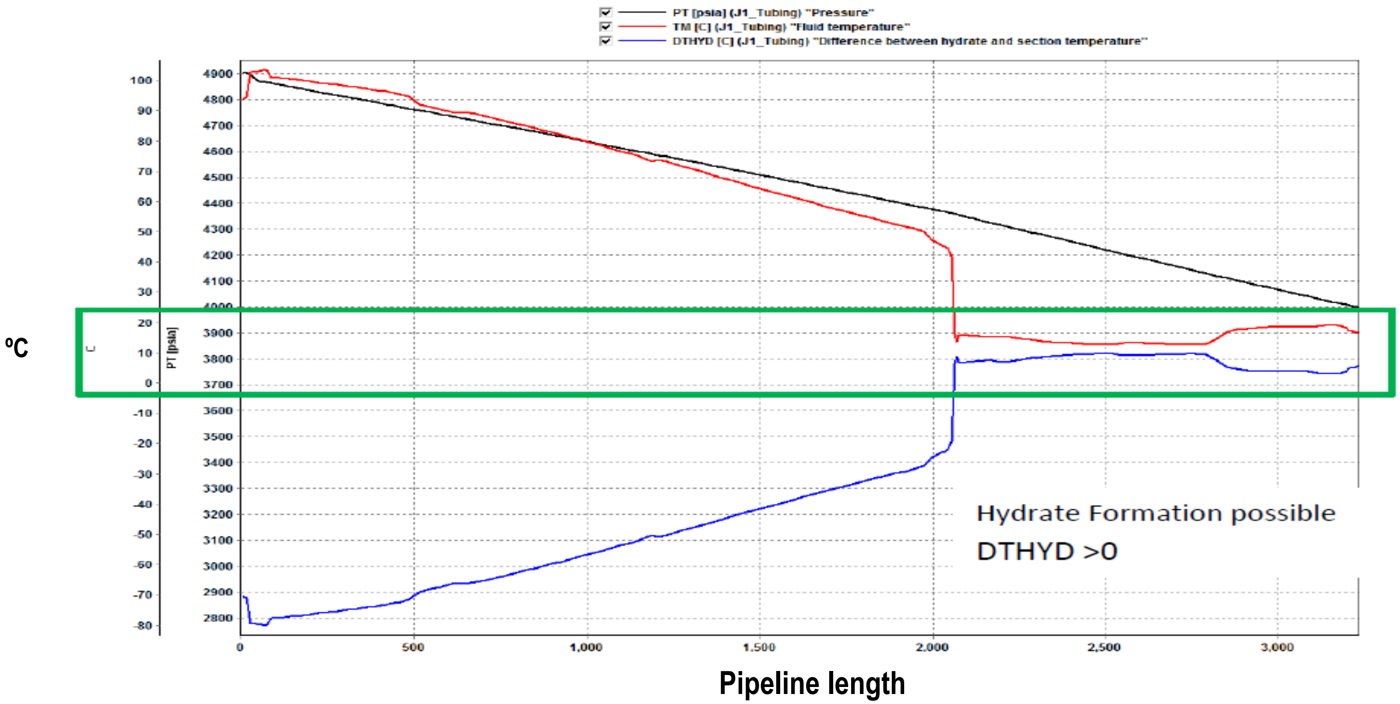
D20 - HYDRATE

- **OLGA** provides the **DTHYD** which is difference between the prevailing temperature at that point and the Hydrate formation temperature at the local operating conditions (DTHYD=Thyd-Tfluid)

- If **DTHYD** is positive then Hydrate Formation is occur



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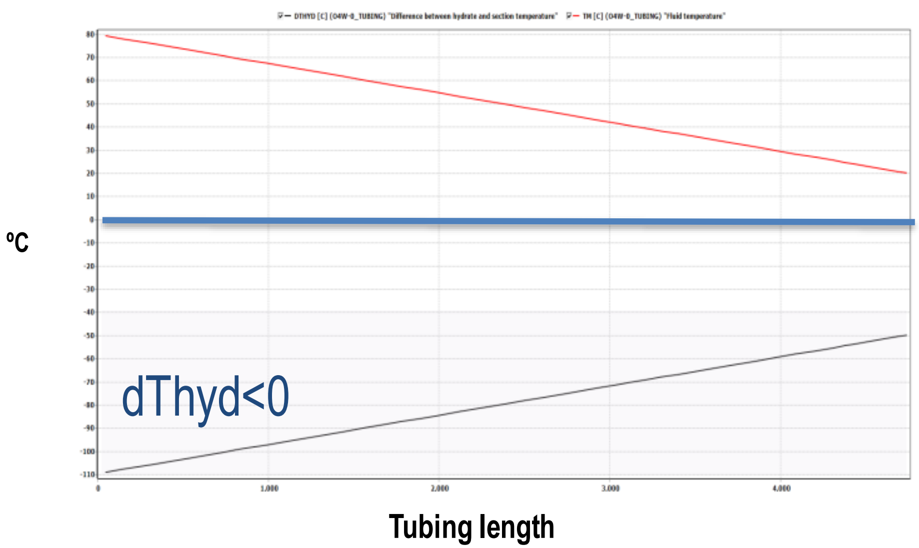
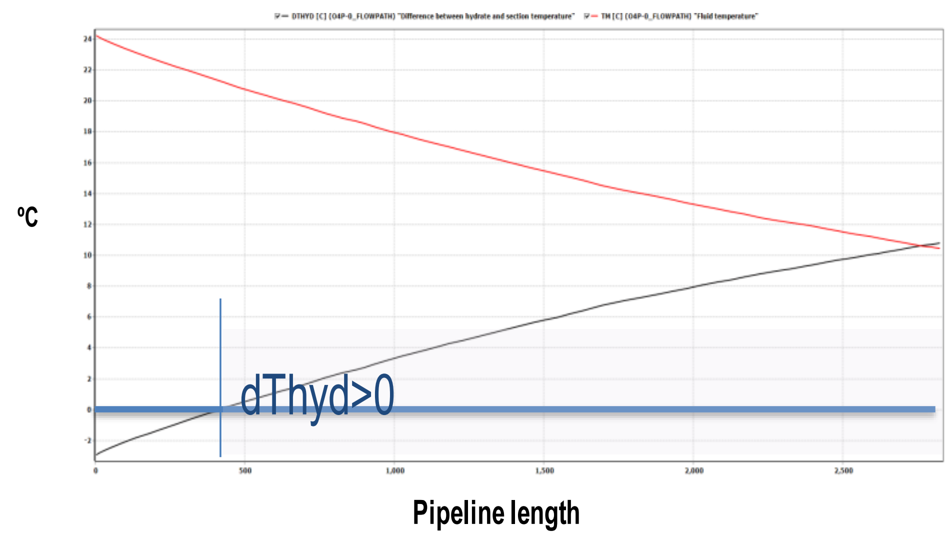
D20 - HYDRATE

Hydrate formation assessment

Fluid temperature **DTHYD**





- No hydrate inside tubing
- Tambient=0°C

- Tfluid <Thyd 400 m away from wellhead
- Tambient=0°C
- dThyd=Thyd-Tfluid

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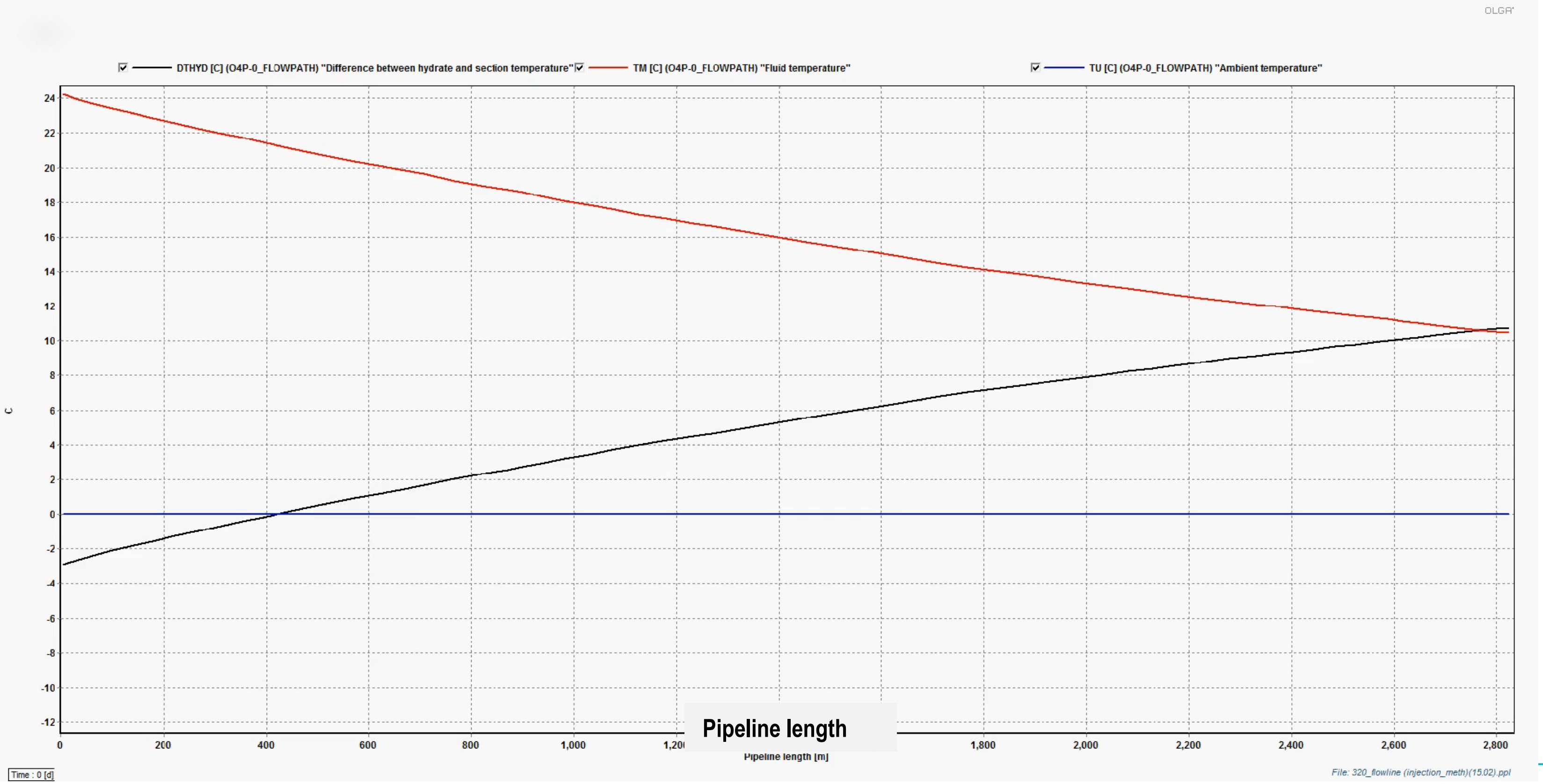
D20 - HYDRATE

Batch pumping of methanol

- Batch injection cannot be used as a preventive measurement (MeOH flows out after 1.5-2 hrs)
- Calculated optimum continuous MeOH injection rates at different ambient temperature

DTHYD Fluid temperature

°C



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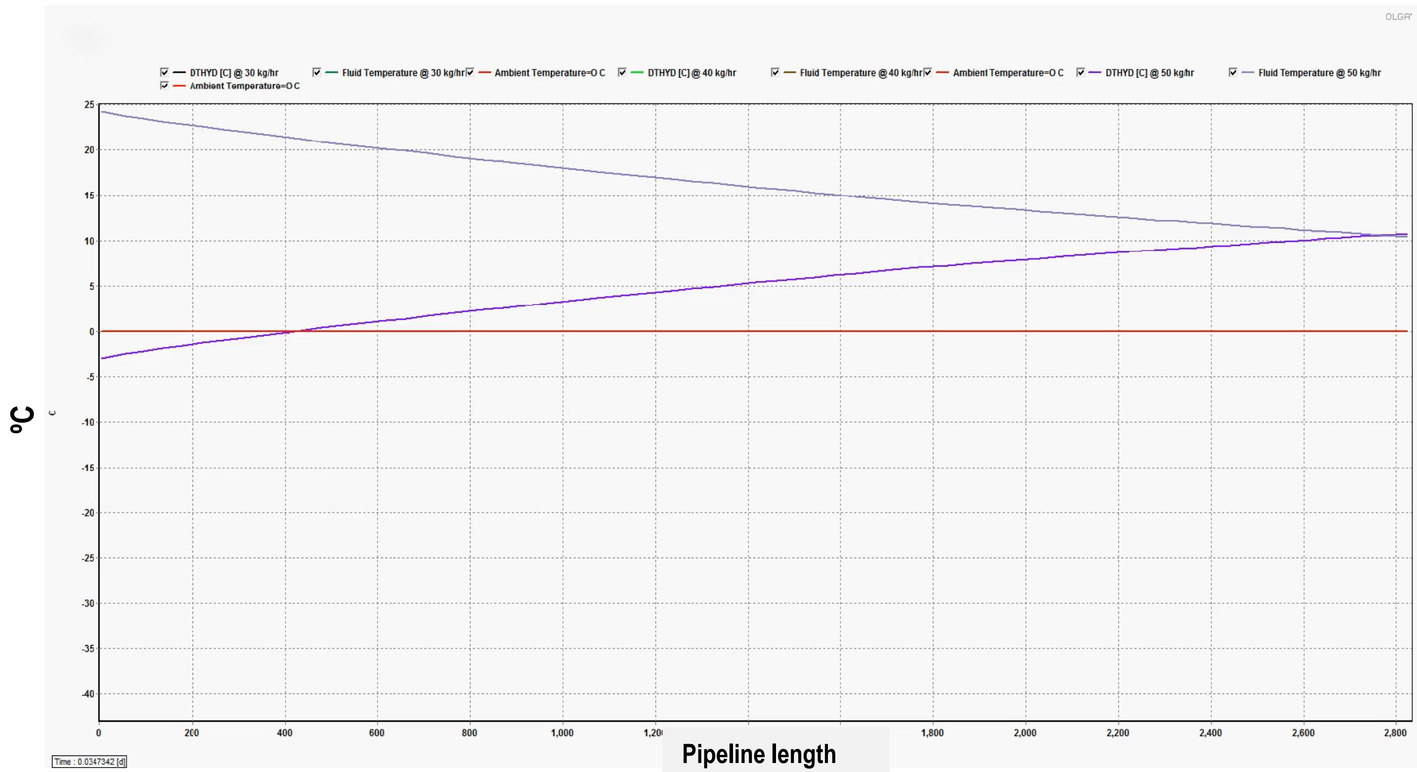
D20 - HYDRATE

Continuous pumping of methanol

Tambient, ºC	MeOH injection rate, kg/hr
0	30
0	40
0	50

30 kg/hr   40 kg/hr   50 kg/hr



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D20 - HYDRATE

Conclusion

- Trace water in hydrocarbon (presence of gas) at the right dP and low temperature can create hydrates
- Batch injection of Methanol (MeOH) is not an effective measure to mitigate hydrates irrespective of volumes pumped
- Only continuous injection of methanol enables stable flow above the hydrate formation temperature
- Installation of chemical injection skid for continuous treatment with methanol is recommended

CONCLUSION

- OLGA as a transient multiphase flow simulator has demonstrated the versatility to predict key flow assurance issues, such as hydrate and wax deposition
- OLGA enabled a better understanding of flow transients and offered a quantitative management strategy of proactive treatments with chemicals to prevent deposition of hydrates and wax
    - Monitoring flow line pressure evolution

ONGOING WORK AND FUTURE STUDIES

Continuous injection of solvent/inhibitor to remove wax deposition

- Laboratory analysis
  - Compositional analysis,
  - Determination WAT at different concentration of solvent in crude oil,
  - Flow loop testing
- OLGA model
  - Lab results to serve as input into further OLGA work to justify continuous injection of solvents/inhibitors in wells and flow lines.

Q&A

THANK YOU

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